GLOBAL GEOMORPHOLOGY
Report of Working Group Number 1:

Leader: Dr. Ian Douglas

First Meeting:

Remote sensing was considered invaluable for seeing landforms in their regional context and in relationship to each other. Sequential images, such as those available from Landsat orbits provide a means of detecting landform change and the operation of large scale processes, such as major floods in semi-arid regions. The use of remote sensing falls into two broad stages:

1. The characterization or accurate description of the features of the earth's surface.
2. The study of landform evolution.

Stage 2 can only deal on the human time scale with relatively small scale changes, but can be invaluable for the study of short-lived phenomena, such as earthquakes, tidal waves and floods. The particularly severe land degradation caused by human activity, such as over-grazing in the Sahel or forest clearance in the Amazon and Himalayan foothills, and its impact on denudation systems can be monitored and assessed. Many of the most serious impacts of such changes are off-site, downwind and downstream.

The multiple data sets now available for many areas provide an opportinity to examine a series of attributes of a given region. It would be useful to prepare a series of maps of an area like the Appalachians to show landform attributes, such as structure, fluvial erosion, evidence of glaciation and karst, and to develop a history of tectonics and denudation. Alternatively the whole American Plate could be examined in detail, looking at patterns to establish geomorphic provinces. Such a study need not be confined to the subaerially exposed parts of the plate but should include the submarine morphology. Information from radar, sonar and radar sea surface altimetry should be incorporated into such a study.

These studies could be regarded as a trial for a system of comparative global geomorphology studies. A global geomorphology working party could be set up to evaluate the pilot investigations and pursue an extended program. However it is essential to insure that geomorphologists are asking the right questions. The working group agreed on the following major questions.

1. How does the surface of the whole earth look at the planetary scale?

2. What are the significant major units at which to look in terms of megageomorphology?

3. Do landforms converge to some (one or more) common types?

4. How do the units identified in question 2 relate to geodynamics? (exogenetic/endogenetic)?

5. What is the global extent of exogenetic landforms?

6. What is the global extent of endogenetic landforms?

7. a. How can we distinguish the changes in geomorphic processes stemming from the modification of ground cover by human action?
   b. What is the relationship between climatic fluctuations and land surface changes?
   c. What will be the geomorphic effects if half the world's population is living in cities by the year 2000?

Questions 1 to 6 relate to extensive static coverage of the earth's surface while question 7 requires sequential imaging of changes at the present time. The first question takes the study of landforms of the earth to the scale of studies of the surface features of the planets. From this fundamental, planetary scale, examination of the earth, the answer to question 2 will emerge. The appropriate units may be the continental and oceanic plates or geomorphic provinces within them. The unit boundaries do not have to conform with the present coastline.

Remote sensing techniques assume that a particular distinctive patern, tone, hue, or signature is made by a single unique feature. However geomorphologists recognize the principle of equifinality, that the same landform may be produced by more than one cause. The extent to which such convergence forms occur at scales at which satellite and space vehicle sensors are used needs to be detected.

Questions 4, 5, and 6 stem from the answers to question 2. Some landforms directly reflect tectonics, while others are direct expressions of the work of running water, wind, ice, or waves. However the extent of such direct relationships is unknown, yet can be readily observed from space imagery.

The influence of climatic fluctuations and human activity over the period since Landsat data became available have locally been great, especially in terms of droughts, floods, forest clearance and over-grazing. Question 7 tackles these changes and endeavors to make the important separation between people-induced effects and natural change. The effects of urbanization are emphasized because of both the growth of urban areas and the demands these place on the surrounding countryside.

Second Meeting:

The group was concerned to tackle scientific questions and to specify some challenging tasks for geomorphological investigations using space imagery. The following questions were identified.

1. The use of space imagery, especially new improved radar sensors, to investigate geomorphic changes during the Quaternary in low latitudes, particularly in forested areas.

2. The investigation of the construction and destruction of volcanoes by collecting a series of images of volcanic cones at different stages of evolution and bringing them together to show the pattern of landform evolution.
   Volcanoes were chosen as the most clear-cut features to use for a pilot study of this type. Similar comparative investigations of other landforms could follow.

3. Tests of the two major concepts of evolution of the earth's surface features, the theory of climatogenetic geomorphology advanced by Büdel and his co-workers, and the relationship between plate tectonics and landforms.

4. The use of space imagery to detect relict features indicative of paleogeomorphology and paleohydrology. The use of SIR-B radar has been particularly significant in this respect.

5. The analysis of the impact of human action on geomorphic processes and their effects on societies through such phenomena as:
   forest clearance
   water diversion
   over-grazing
   urbanization
   together with the effects of climatic variability on societies.

Question 1 tackles the fundamental issue of how can features caused by Pleistocene aridity in the tropics be recognized. SIR-B data from areas such as Borneo indicates that landforms beneath tropical rainforest can be recognized but the sensors need further improvement. It would be useful to have sensors capable of revealing information about the depth of weathering and the presence of bauxitic, ferruginous or siliceous duracrusts. Work using SLAR 10 years ago enabled the Quaternary landform history of part of the Amazon basin to be revealed. However, shuttle radar imaging systems would greatly speed up this work in other forested tropical areas. Such work is of economic significance, stratographic work in S.E. Asia, for example, indicates important alluvial ore deposits in buried braided stream channels which formed under seasonally dry climates at times of Quaternary low sea level.

Question 2 is a modeling exercise using empirical data from actual landform examples which can easily be measured or digitized from space images. Development of such technology would enable far better predictions to be made of the changes in landformevolution likely to occur as a result of large scale engineering or land development works.

The third question turns to fundamentals of theory in geomorphology. Büdel argued that etchplanation processes under seasonally wet climates prevailed over much of the earth in the early Tertiary and that remnants of the erosion surfaces so created are to be found in many areas. The signatures of the features could be recognized on appropriate images, their extent mapped and the evidence evaluated against the results of conventional field studies. Similar tasks could be undertaken with tectonic features to come closer to the problem of the relative roles of climate and tectonics in landform evolution.

Question 4 extends the use of imagery to detect traces of relict landforms and inherited features. It recognizes that much of the character of the earth's surface was determined under different combinations of geomorphic processes from those at present operating. By examining the consequences of past changes, the likely effects of future changes, such as global cooling or global warming, become more easily predictable.

Question 5 returns to the issues discussed in relation to the seventh question at the first meeting of the working group. The role of sequential images in seeing the consequences of both short-lived extreme events and the slower, more insidious degradation of the land by human action cannot be over emphasized.

Overall, the working group was enthusiastic about the prospects for global geomorphology and urged a continuing effort to develop concepts, scientific ideas, methods, instrumentation and means of access to and use of remote sensing data.